Combined Heat and Power

- Applications and Benefits -

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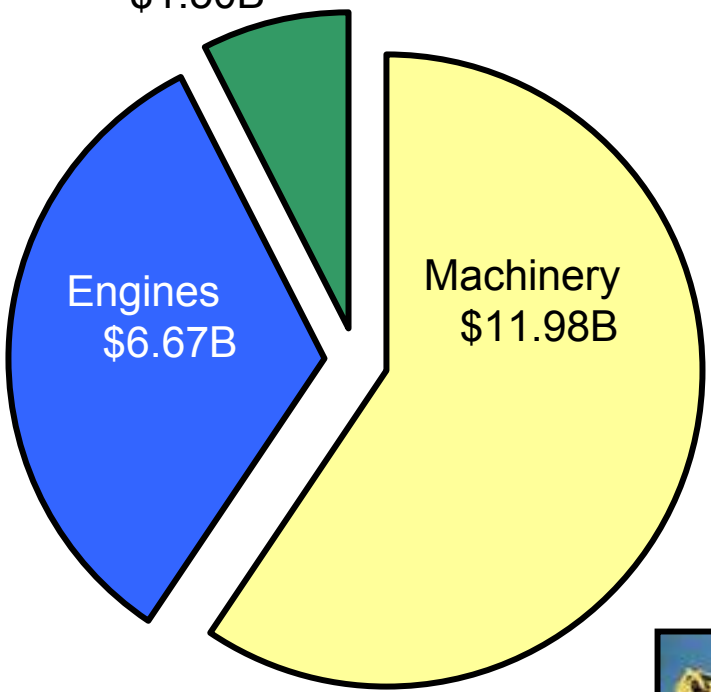
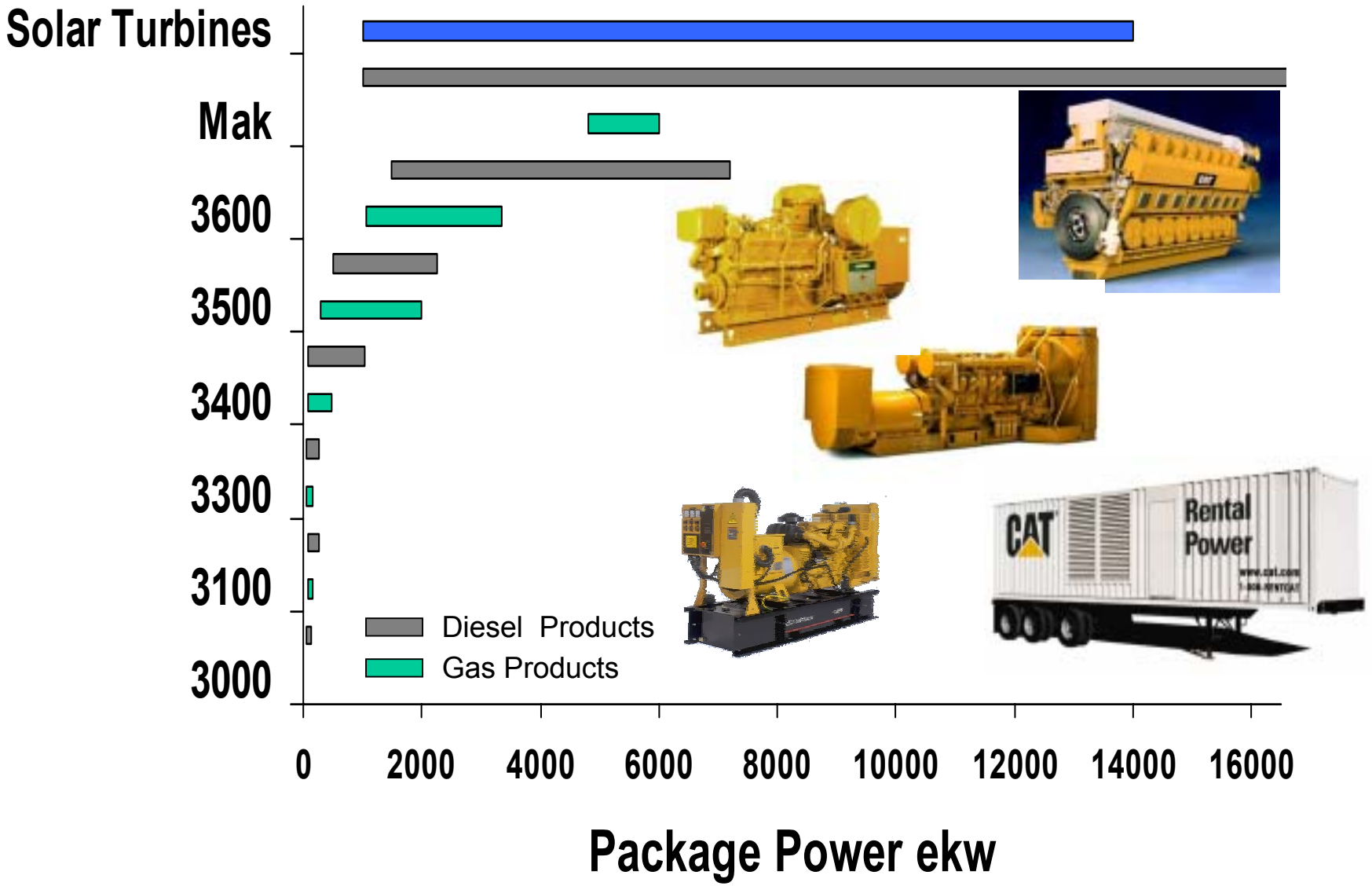
CAT® Electric Power

Caterpillar Inc $20.15B*



*2002 Results

Caterpillar Power Products



Caterpillar Dealer Network

North America:
- 64 Caterpillar Dealers
- 517 Branch Stores
- 34,000 Employees
- 244 Rental Stores
- $3.5B Net Worth

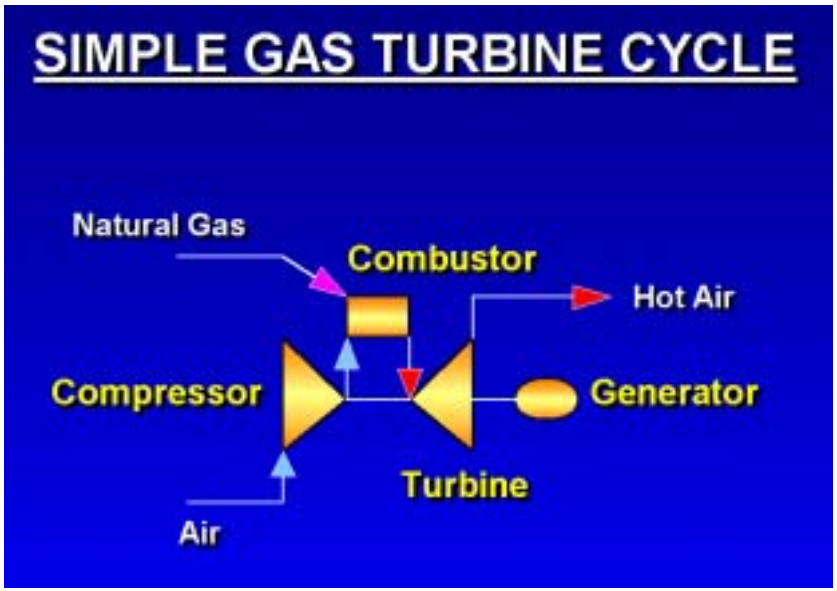
Local Cat Dealer

WAGNER Power Systems

2MW Power Module on Display

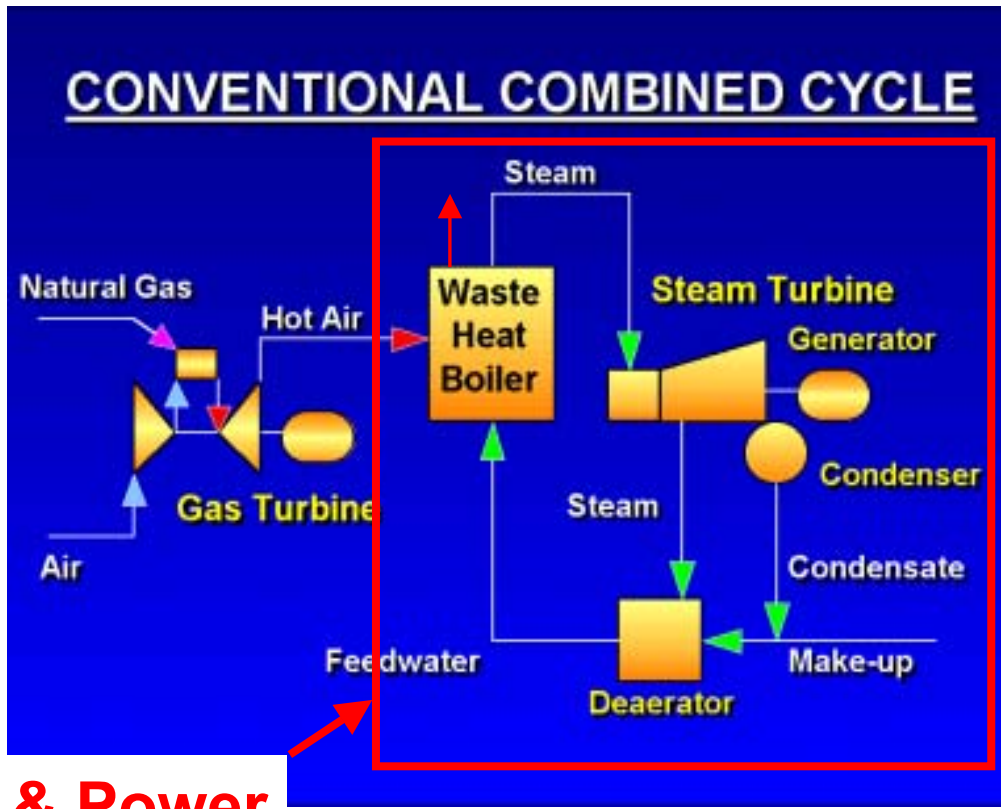
Combined Heat and Power Definitions

Combined Heat and Power (CHP) generates simultaneous and sequential use of power and heat at or near the point of use.



52% - 58% Electrical Efficiency
42% - 48% Waste Heat
Large (>50MW) Systems

CCGT



NOT Combined Heat & Power

Combined Heat and Power Definitions

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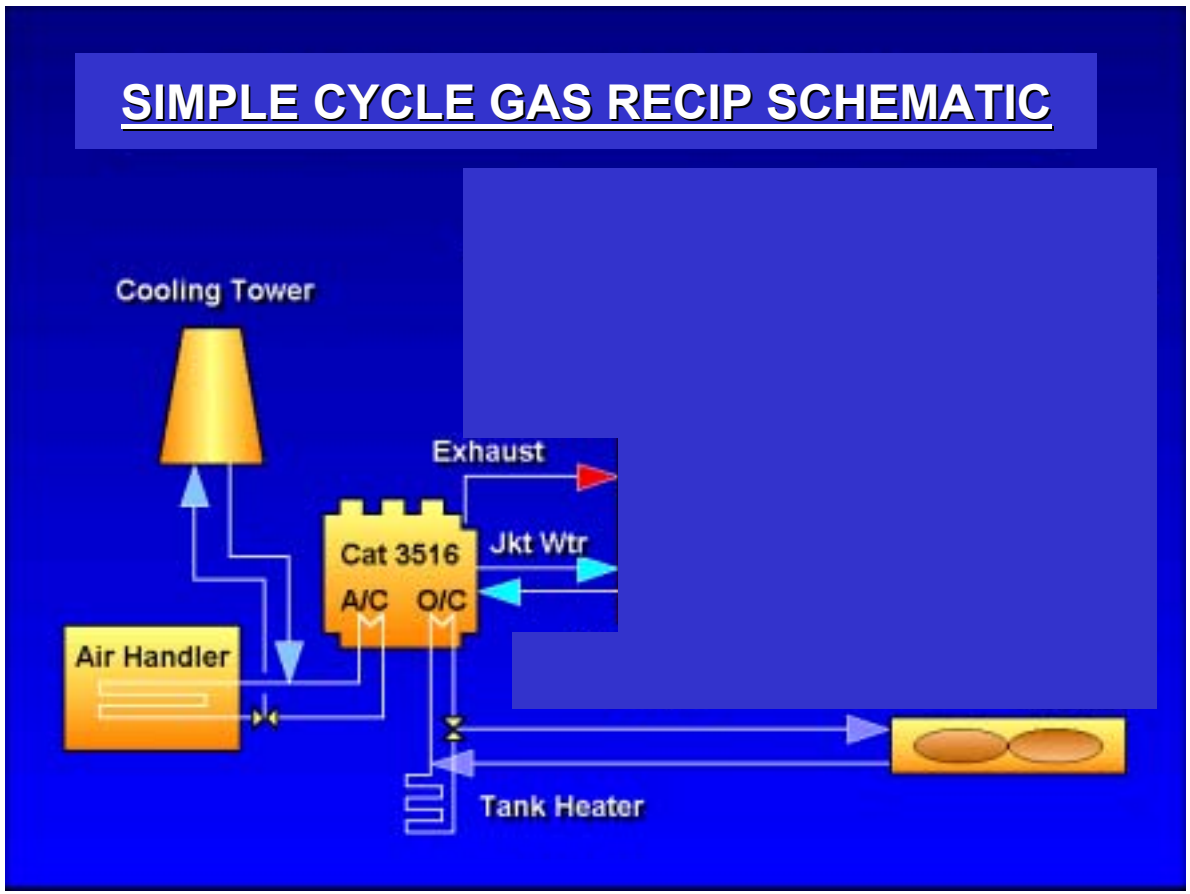
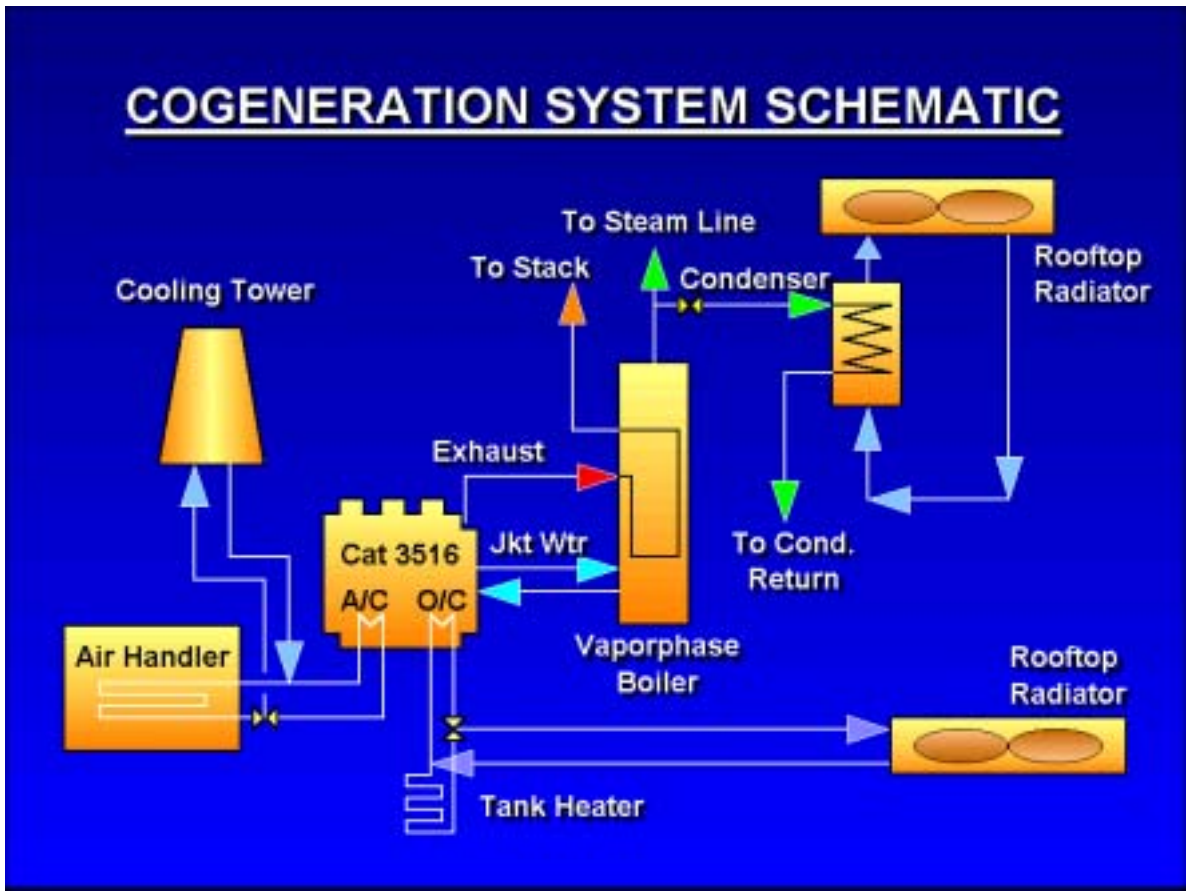


34% - 43% Elec Efficiency
58% - 66% Waste Heat
Simple, Widespread

Combined Heat and Power Definitions

Combined Heat and Power (CHP) generates simultaneous and sequential use of power and heat at or near the point of use.



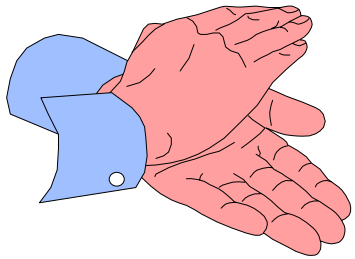
60% - 75% Useful Work
25% - 40% Waste Heat
Typical (<10MW) Systems

Additional Heat Recovery
-Aftercooler Loop
- Oil Cooler Loop
75% - 85% Total Efficiency
15% - 25% Waste Heat

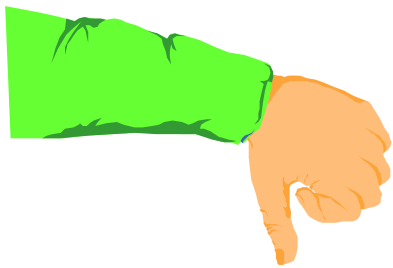
This IS CHP

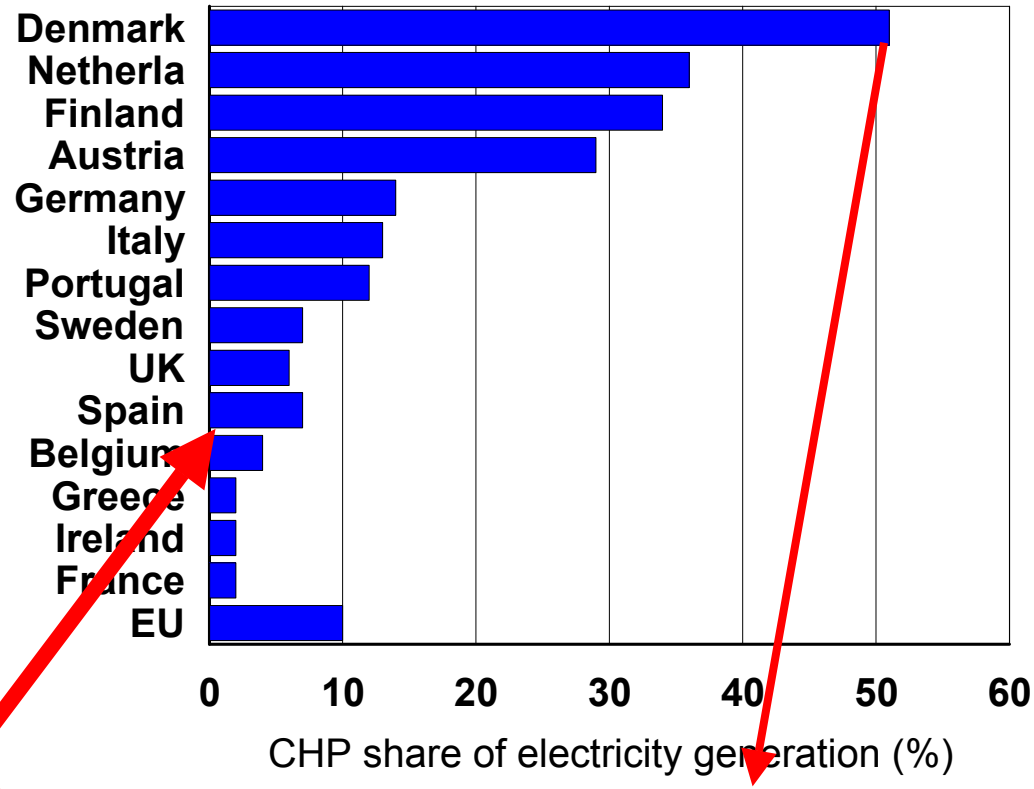
Combined Heat and Power Today

Europe =



USA =

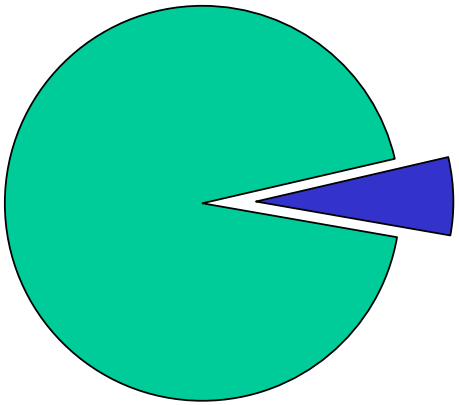




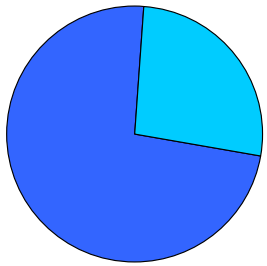
50.4 GW Installed = 6.5%
2010 Goal 92GW = 12 %

US Combined Heat and Power

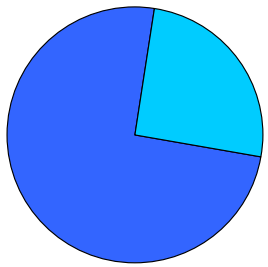
In the US Today…



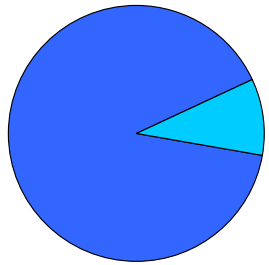
50.4 GW of CHP
6.5% of Total Capacity



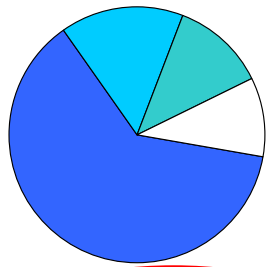
80% In >50MW Systems



37.6 GW Grid Export
12.8 GW Grid Balance



45.5 GW Industrial
4.9 GW Commercial

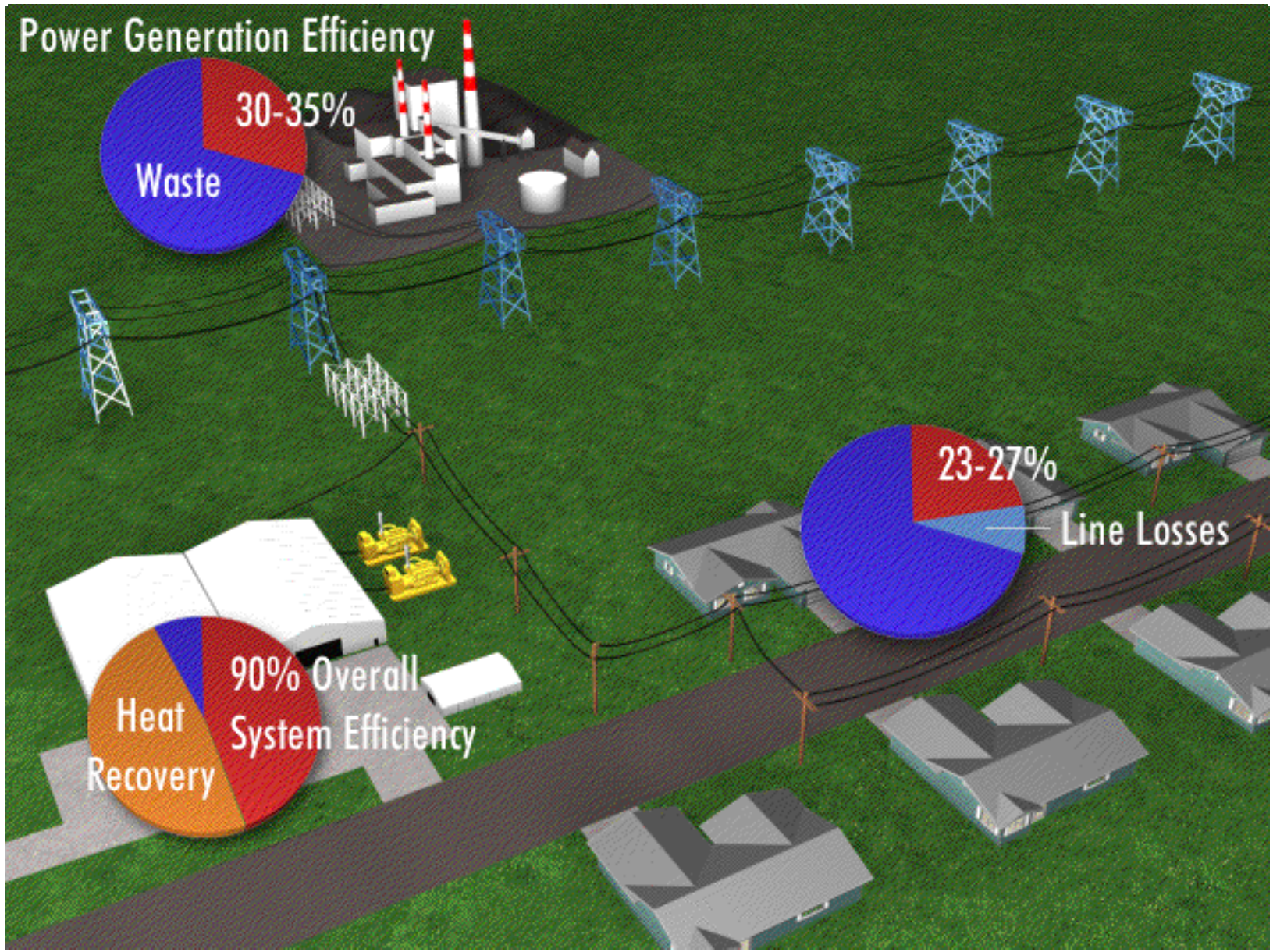


31.5 GW Natural Gas
7.8 GW Coal
6.1 GW Wood / Waste
5.0 GW Other

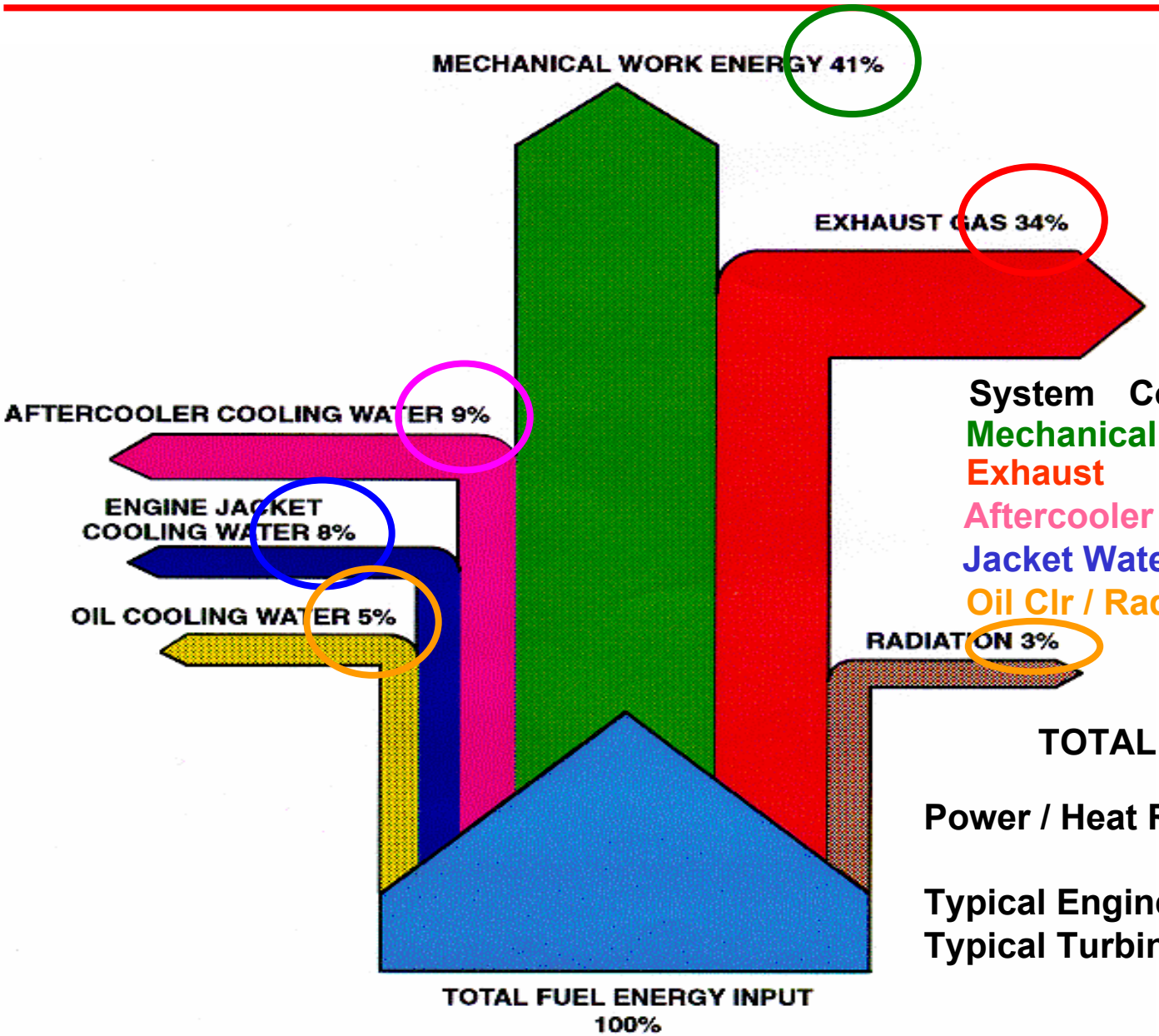
U.S. CHPA — United States Combined Heat & Power Association

www.uschpa.org

Combined Heat and Power Definitions



1250 eKW Recip CHP



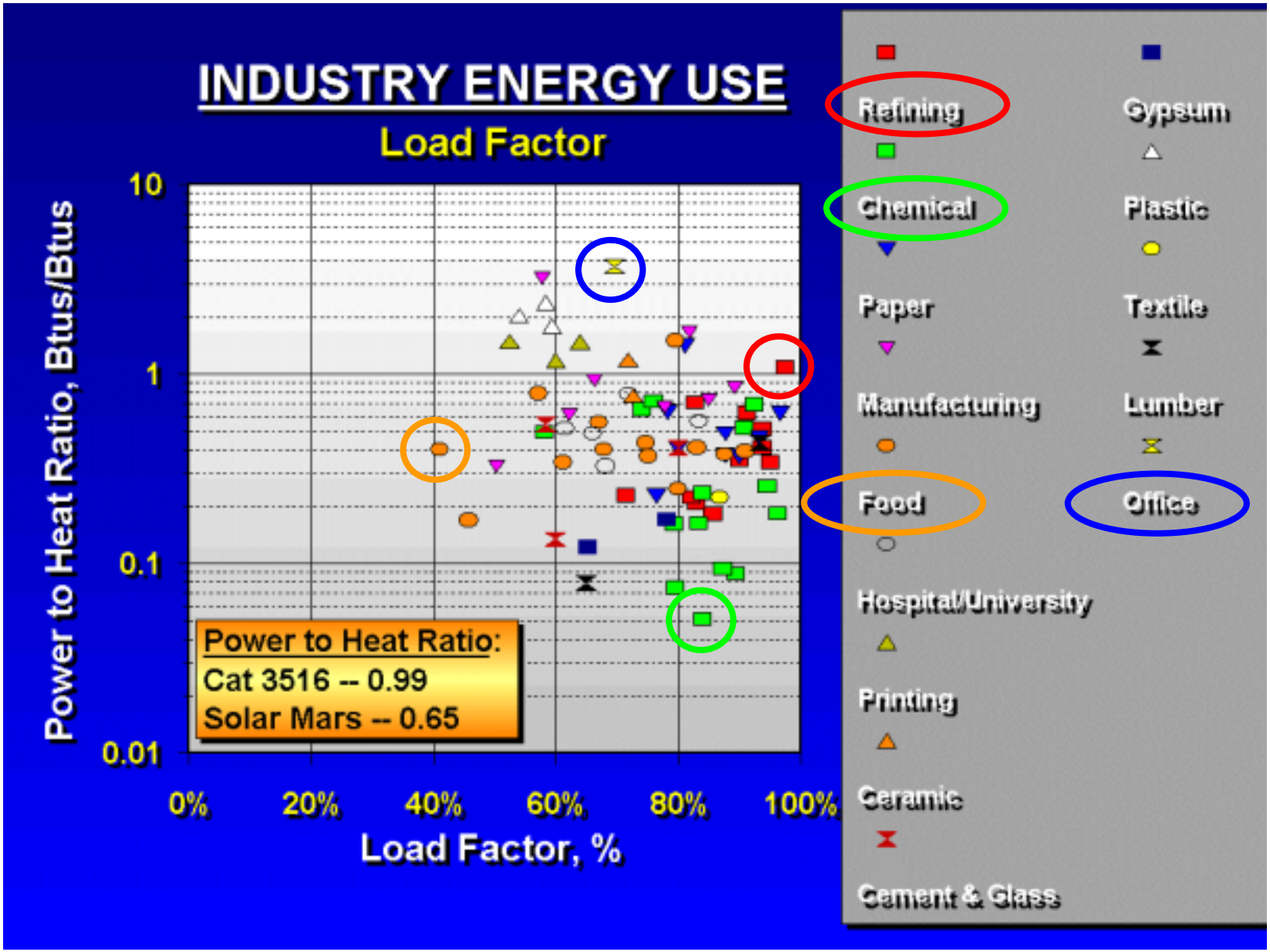
System	Conversion	Result	
Mechanical	100%	41%	
Exhaust	75%	26%	
Aftercooler	80%	7%	39%
Jacket Water	80%	6%	
Oil Clr / Rad	0%	0%	

TOTAL 80%

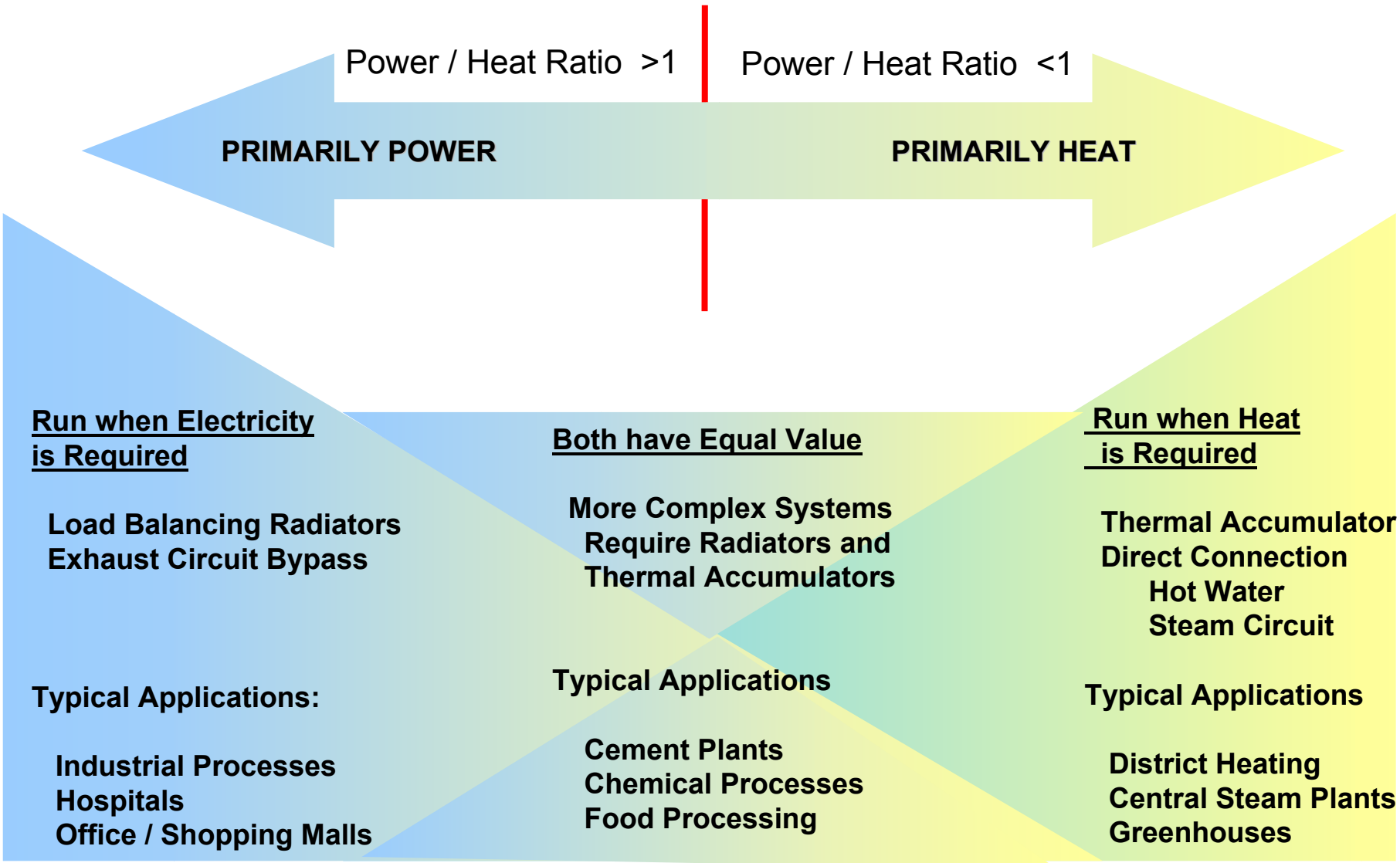
Power / Heat Ratio = 41/39 = 1.05

Typical Engine Ratio = 0.6 – 1.5
Typical Turbine Ratio = 0.3 – 0.8

CHP Applications



Combined Heat and Power Definitions



CHP is Everywhere

Mobile Applications:

- Engine for Power
- Boiler for Cab Heat

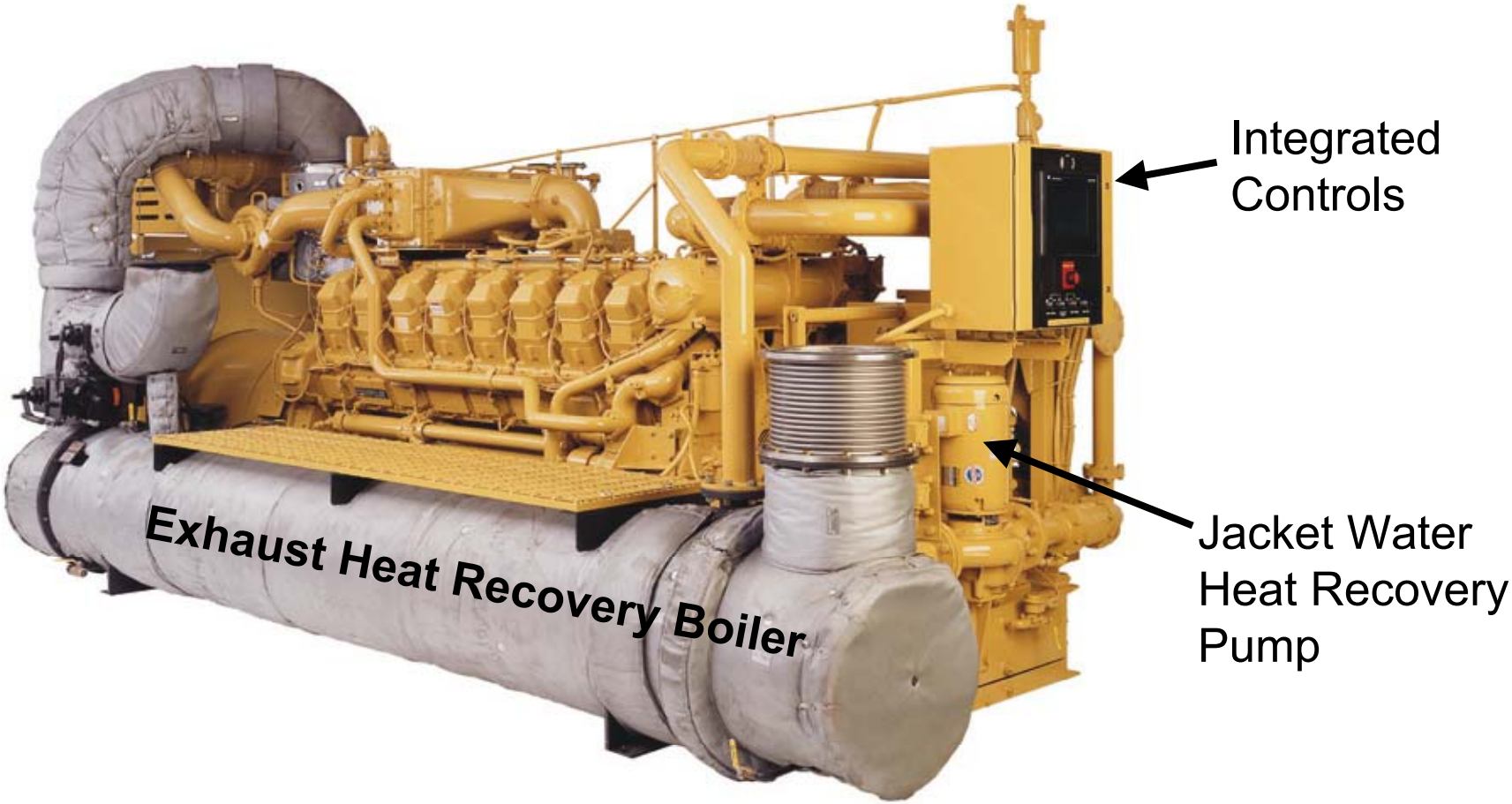
↓

- Engine for Power
- Hot Water for Cab Heat

Stationary Applications:

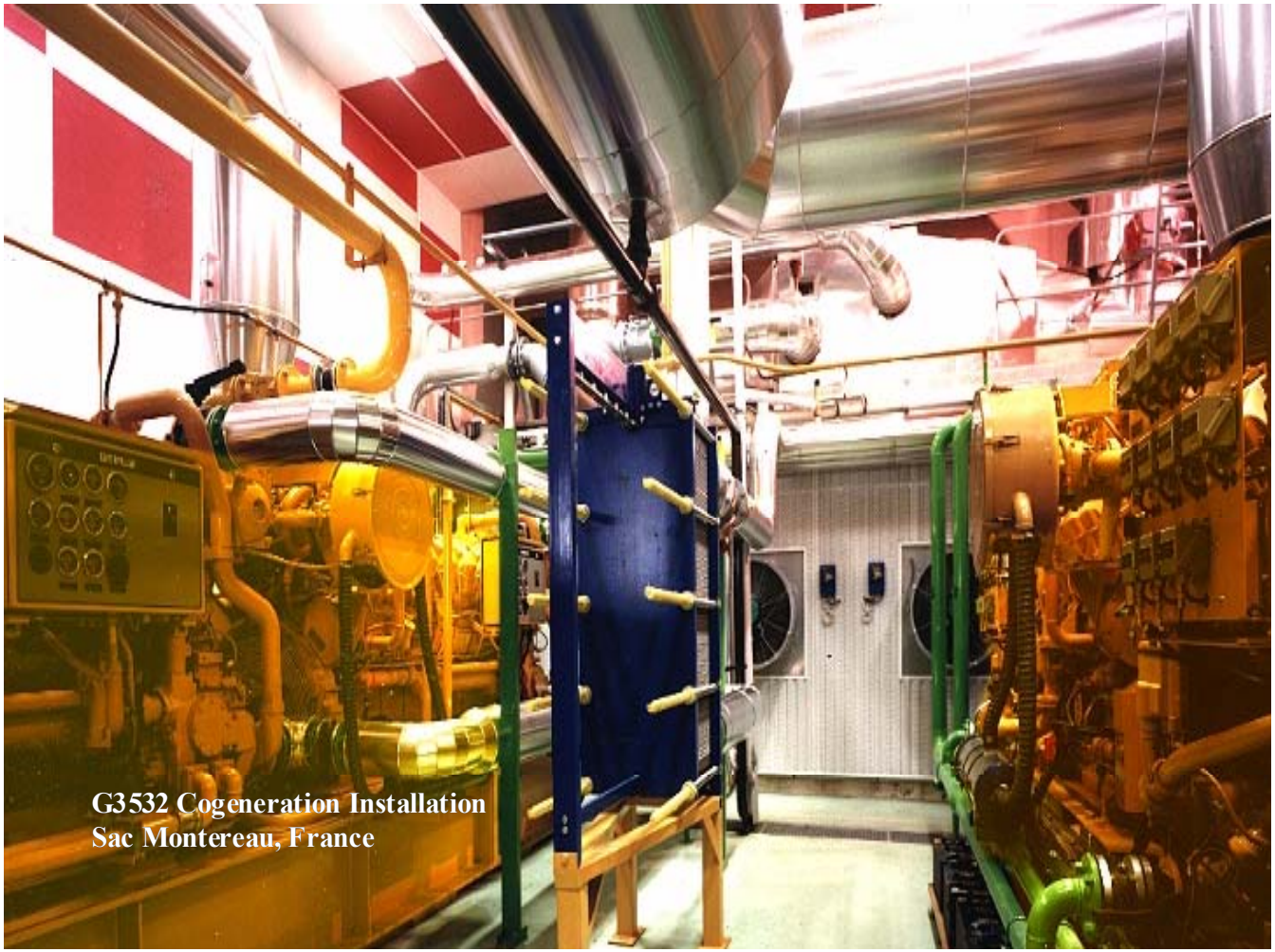
Steam Production	Chilling	Hot Air
Pulp and Paper	Hospitals	Cement Plants
Breweries	Hotels	Grain Drying
Refining	Universities	Gypsum Plants
Chemical Plants	Office Buildings	Boiler Preheating
Food Processing	Pharmaceuticals	Space Heating

CHP Stationary Applications



1.25MW Natural Gas CHP Genset
75% - 85% Total Efficiency
~$600 - $800 / ekw Installed

CHP Stationary Applications



District CHP Application
St. Montereau, France
Typical 85% Efficiency

CHP Stationary Applications

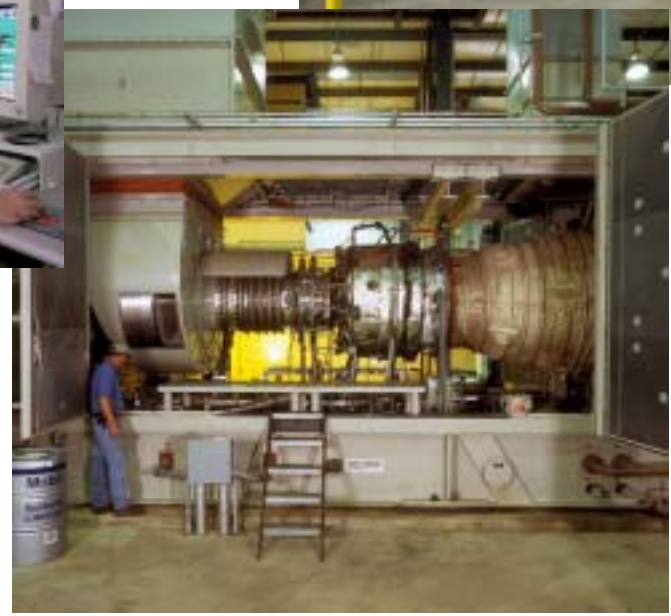
Simple CHP Application
High School in Kansas
Typical 65% CHP Efficiency

CHP Stationary Applications

Industrial CHP Application
Plastics facility in Chicago
Typical 70% CHP Efficiency

CHP Stationary Applications

Medina CHP – IL
Power
Steam
Cooling
Typical 80% Efficiency

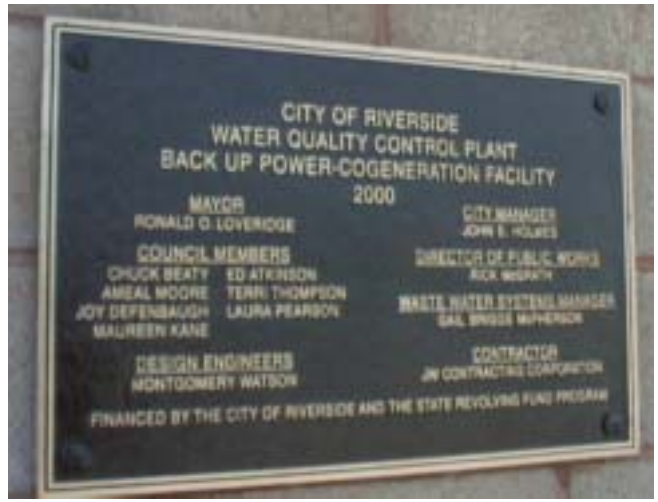


CHP Stationary Applications

Waukesha at NW Community Hospital (IL):
3MW: CHP & Peak Shaving

Cummins St. Catherine's General Hospital (Ontario):
2.5 MW CHP

CHP Stationary Applications

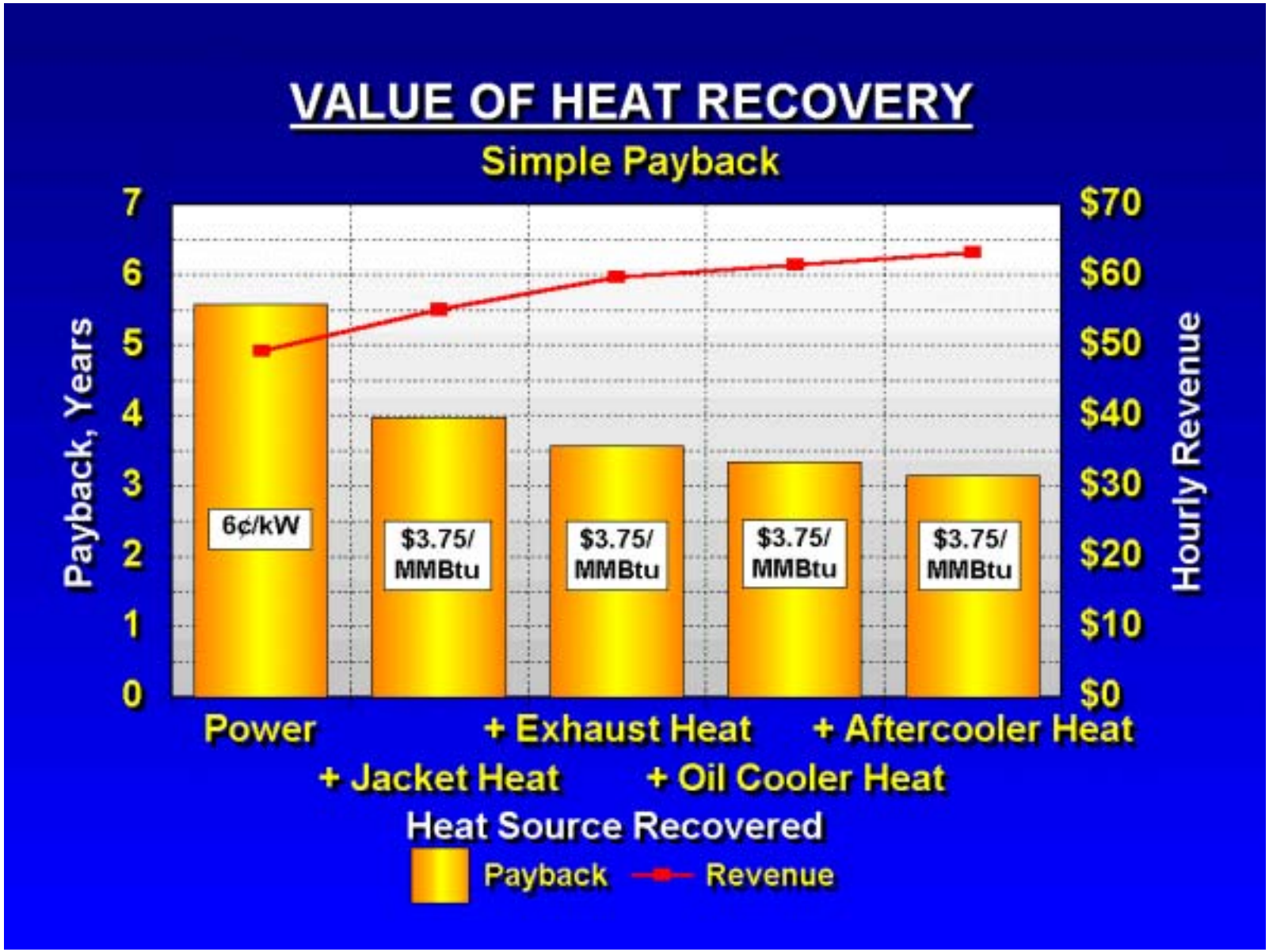


City Digester Plant – Riverside CA
Digester – Landfill – Natural Gas
Typical 70% CHP Efficiency

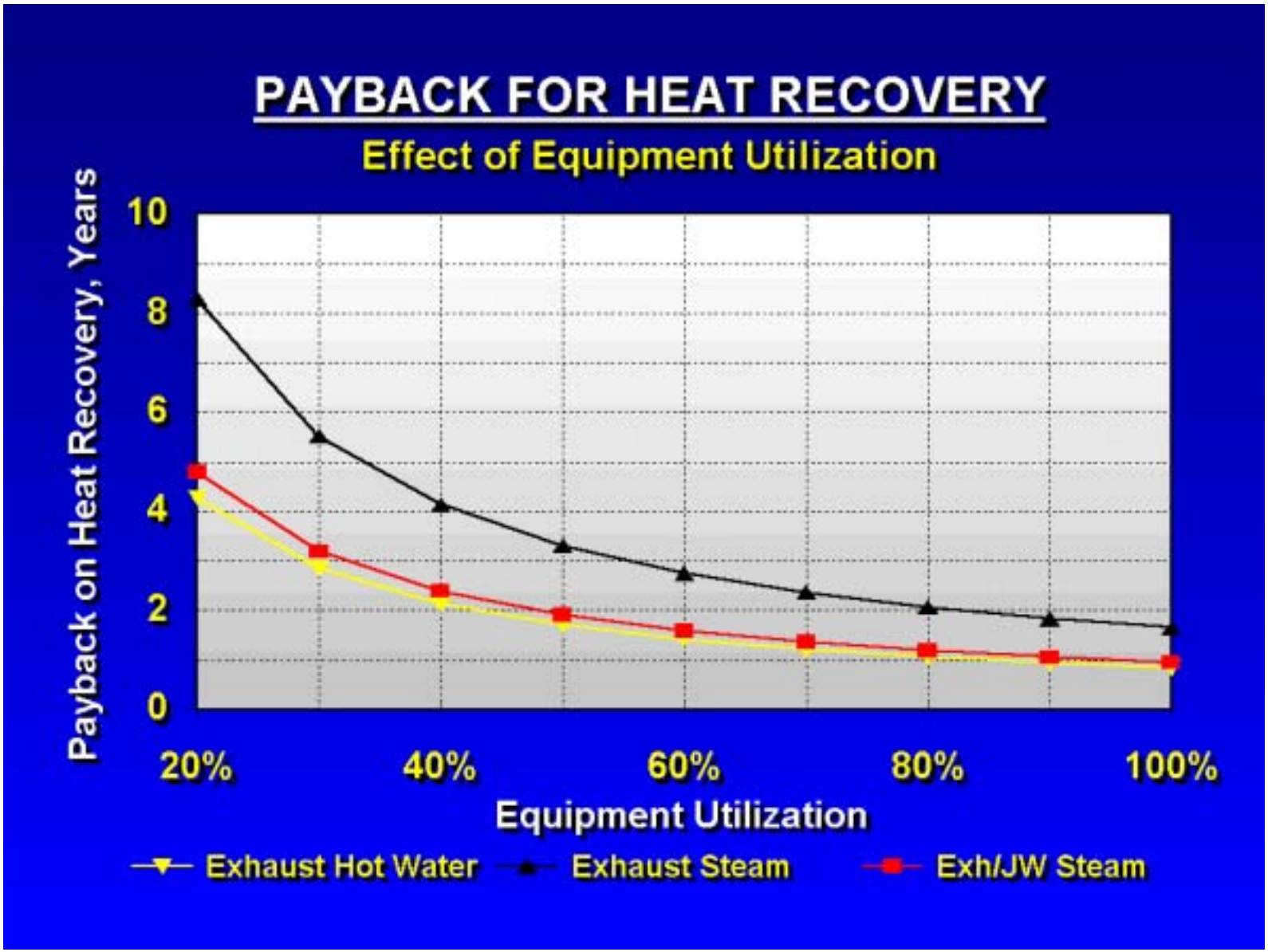
CHP Stationary Applications

District Heating
Bramming, Denmark
94.2% CHP Combined Efficiency

CHP Benefits

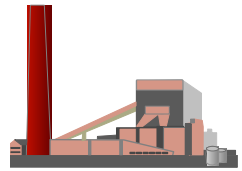


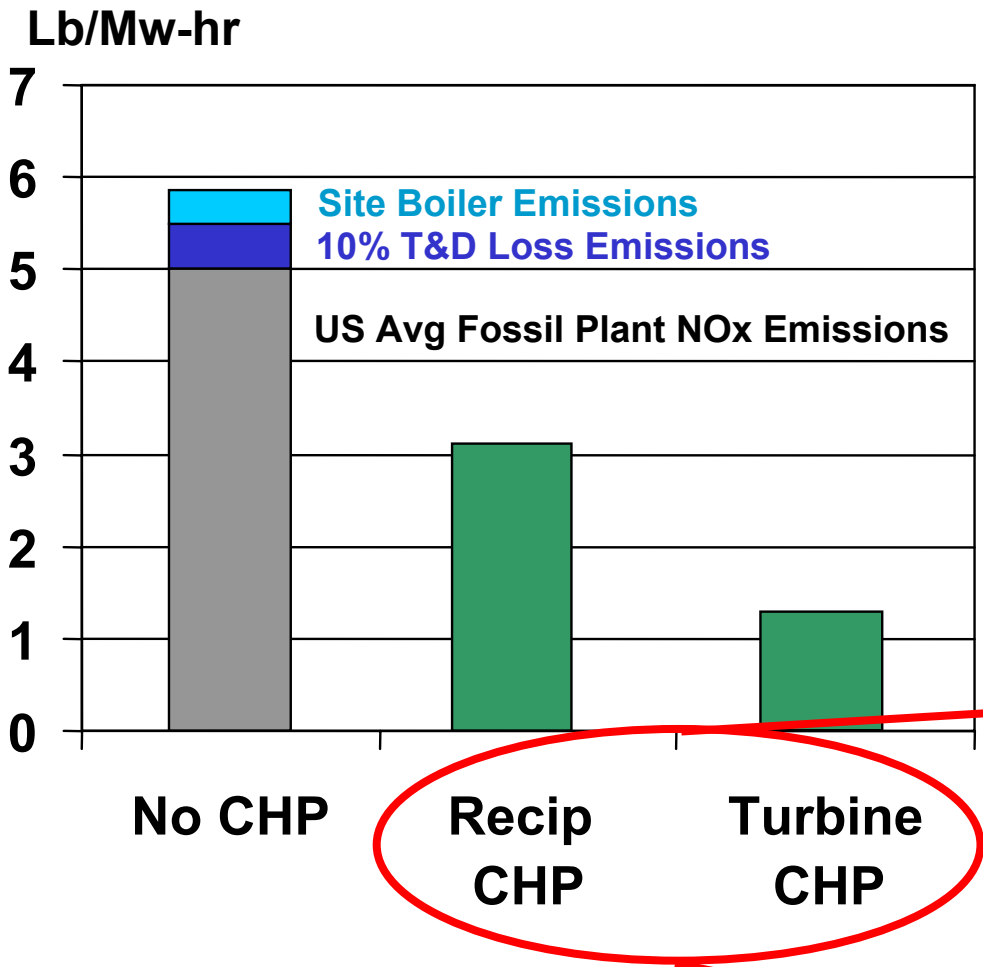
CHP Benefits



CHP Benefits

Emissions Reduction – The Hidden Benefit





Site Requirements:
- 1000 kw Electricity
- 750 kw Heat
- 8000 hr/yr Operation
  (Power / Heat = 1.33)

No CHP = 23.4 tons/yr

With Recip CHP = 12.4 tons/yr

With Turbine CHP = 5.2 tons/yr

Selection depends on:
- Economic Payback
- Power / Heat Ratio
- Size / Space Needs
- Fuel Pressure
- Etc

Should I Do CHP?

Issues:

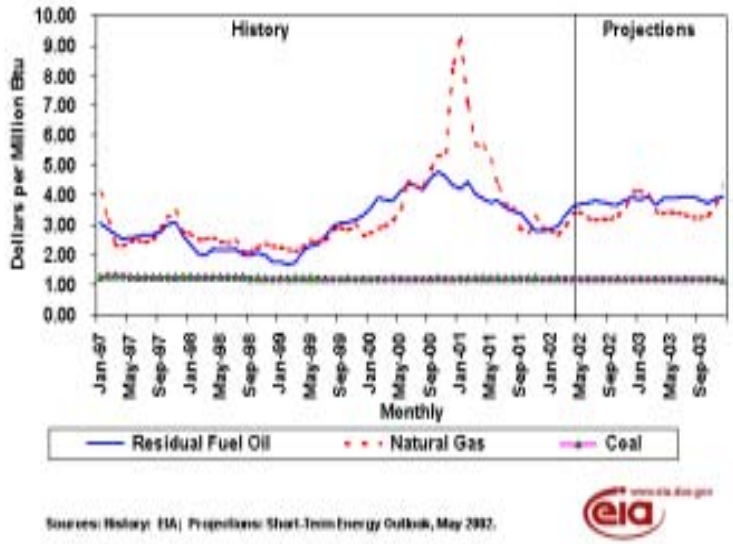
1 Interconnection and Interface Requirements
  Involve your Utility / Equipment Supplier Early

1 Environmental Impacts
  Air Emissions, Vibration, Noise, Physical Size

1 System Economics, Understand your Power / Heat
  Long Term Fuel and Electricity Pricing
  Costs of Power / Heat Outages
  Power Quality Needs

Application	Outage $ / Hour
Cell Communications	$41,000
Telephone Ticket Sales	$72,000
Airline Reservations	$90,000
Credit Card Operations	$2,588,000
Brokerages	$6,480,000
Your Operation	??

Figure 11. Fossil Fuel Prices to Electric Utilities



CHP Summary

- ✓CHP systems are a well defined and documented technology
- ✓CHP is available today from many sources using many techniques
- ✓CHP can benefit customers, regulators, and environmentalists
- ✓CHP requires
  - ✓A clear agreement on interconnection and interface
  - ✓A clear regulatory environment that encourages CHP benefits
  - ✓A clear cost / benefit and economic analysis

✓ CHP may indeed work for you.

THANK YOU!

QUESTIONS?